A Prospective Study of

ANALYSIS OF FUNCTIONAL OUTCOME OF MULLER'S TYPE A AND C FRACTURES DISTAL FEMUR USING LOCKING COMPRESSION CONDYLAR PLATE

Dissertation submitted to

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M.S (ORTHOPAEDIC SURGERY)

BRANCH-II

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CERTIFICATE

This is to certify that **Dr. J. PAZHANI,** post graduate student(2008-2010) in the Department of Orthopedic Surgery, **Government Royapettah Hospital, Kilpauk Medical College,** has done dissertation on **'ANALYSIS OF FUNCTIONAL OUTCOME OF MULLER'S TYPE A AND C FRACTURES DISTAL FEMUR USING LOCKING COMPRESSION CONDYLAR PLATE'** under my guidance and supervision in partial fulfillment of the regulation laid down by the '**THE TAMILNADU DR MGR MEDICAL UNIVERSITY, CHENNAI 32'.** for M.S. (Orthopaedic Surgery) Degree Examination to be held in March 2010.

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DECLARATION

I **Dr. J. PAZHANI,** solemnly, declare that dissertation titled **'ANALYSIS OF FUNCTIONAL OUTCOME OF MULLER'S TYPE A AND C FRACTURES DISTAL FEMUR USING LOCKING COMPRESSION CONDYLAR PLATE**' is a Bonafide work done by me at government Royapettah Hospital, Kilpauk medical college between 2008-2009, under the guidance and supervision of our Head of the Department and my Unit Chief **Prof. Dr. K.NAGAPPAN, M.S (Ortho), D.Ortho.,**

This dissertation is submitted to **THE TAMILNADU DR MGR MEDICAL UNIVERSITY CHENNAI,** towards partial fulfillment of regulation for the award of M.S.DEGREE BRANCH II in Orthopedic Surgery.

Place : Chennai

Date: **(Dr. J. PAZHANI)**

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CONTENTS

INTRODUCTION

INTRODUCTION

Fractures of the distal femur are complex injuries. They can produce significant long term disability. They account for 7% of all femoral fractures. If hip Fractures are excluded, 31% of femoral fractures involve distal portion. Although open reduction and internal fixation with plate and screws has Become a standard method of treatment for many types of fractures, the Management of comminuted, intra articular distal femoral fractures still remains Complex and challenging to the orthopaedic surgeon. Many of these fractures are the result of high energy trauma which generates severe soft tissue damage and articular and metaphyseal communition.

The incidence of malunion, nonunion and infection are relatively high in many reported series. Coronal plane fractures and extensively communited fractures preclude the use of commonly used devices like 95 degree condylar blade plate, the dynamic Condylar screw with 95 degree side plate and supracondylar nails. Lateral buttress or neutralization plate may be used, but when this device is applied in presence of **Medial comminution or bone loss**, failure of fixation and **varus collapse** may eventually result.

Recent advances in technology for the treatment of distal femoral fractures include the less invasive stabilization system (LISS) and the **locking compression Condylar plates**. They offer multiple points of fixed angle contact between the plate and screws in distal femur, reducing the tendency for varus collapse and at the same time afford better stability.

AIM OF THE STUDY

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The aim of the study is to **"ANALYSE THE FUNCTIONAL OUTCOME OF MULLER'S TYPE A and C DISTAL FEMUR FRACTURES TREATED WITH LOCKING COMPRESSION CONDYLAR PLATE"** at the department of Orthopedics and traumatology, Government Royapettah Hospital, Government Kilpauk Medical College, Chennai, between JULY 2008 and OCTOBER 2009.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORICAL REVIEW

In 1770, LAPEJODE AND SIORE first used brass wire to internally fix long bone fractures. Different techniques and methods of internal fixation were used, with mixed success between 1770 and 1965.

In 1965, Muller, suggested L shaped compression plate (ASIF condylar plate). Later on in 1966, MARCUS J STEWART,SISK AND WALLACE retrospectively reviewed 213 supracondylar and intercondylar femur fractures and recommended, two pin traction as treatment of choice. In 1970, A.O. method of internal fixation became popular and OLERUD (1972), reported 93% satisfactory results treated with blade plates, but procedure was technically demanding with high rate of inadequate fixation which resulted in refracture afterplate removal. The failure rate was high especially in osteoporotic bone.

In 1986, REGAZONNI, RUEDI and ALLGOWER used the dynamic condylar screw implant system for fractures of distal femur, but the main disadvantage of Condylar screw implant was that the insertion of condylar lag screw requires removal of large amount of bone which made revision surgeries more difficult and varus collapse was a recognized complication.

In 1991, SANDERS R., SWIONTKOWSKI, used double plating or comminuted, unstable fracture of distal femur.

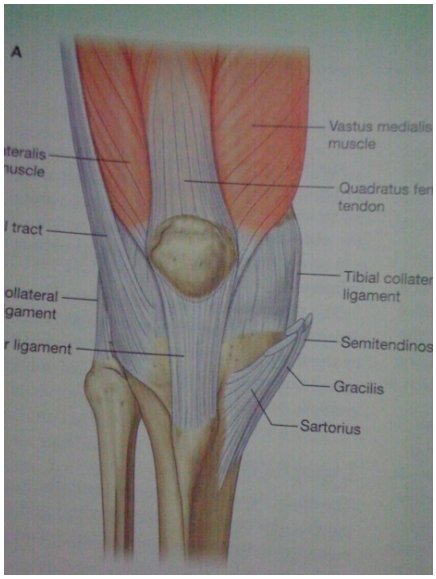
In 2000, LCP was approved as new AO plate standard.

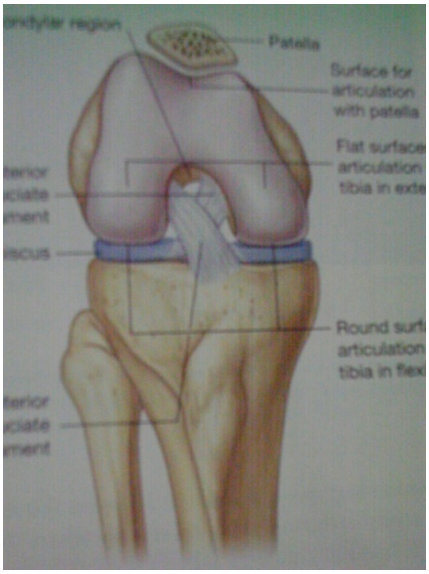
APPLIED ANATOMY [2f, 24, 26]

The supracondylar area of femur is defined as, the zone between thefemoral condyles and the junction of the metaphysis with the femoralshaft. At junction of distal femoral diaphysis and the metaphysic, the femur flares into two curved condyles. The anterior surface, between the two condyles, has a shallow depression for articulation with the patella. The posterior surface is separated by a deep intercondylar fossa. The lateral condyle is broader than the medial condyle and projects forward helping to stabilize the patella. The medial condyle is longer and extend farther distally than the lateral condyle and is convex medially. When viewing the lateral surface of distal femur, it is observed the condyles are wider posteriorly, thus giving a trapezoidal shape to the distal femur.

The knee joint is a complex synovial joint of modified Hinge variety. It is a compound joint that includes two condylar joints between the femur and the tibia and a saddle joint between the patella and the femur. Here the flexion and extension takes place around a transverse axis, but the axis is not constant. In fully extended position, the tibial tubercles are lodged in the

ANATOMY


A
Vastus medialis muscle
Quadratus fer tendon
Tibial collater ligament
Semitendinos
Gracilis
Sartorius


Patella
Surface for articulation with patella
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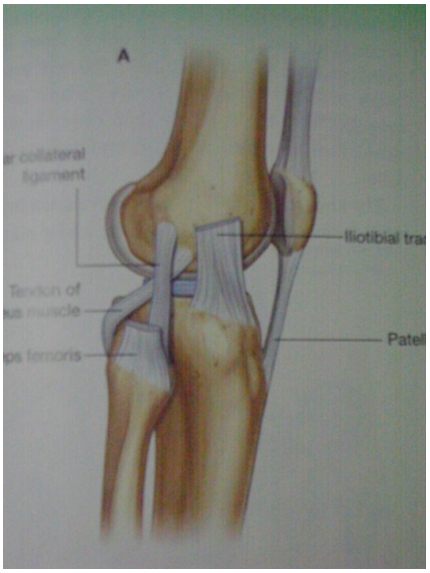
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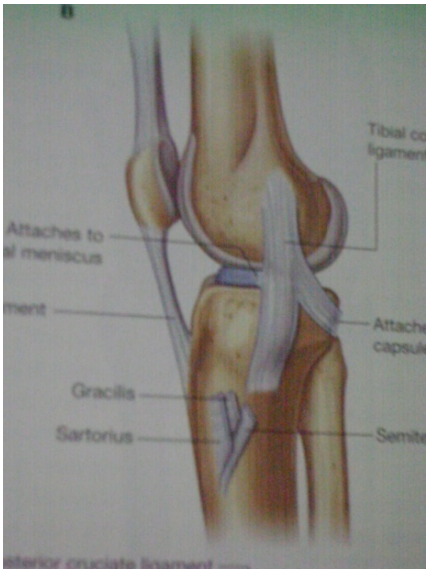

B
Attaches to
Gracilis
Sartorius

intercondylar notch and the menisci are tightly wedged between the femoraland tibial condyles. The quadriceps muscle is the main extensor of knee consisting of four heads (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius).

The Vastus medialis is the most important component responsible for the last 10 degrees of extension. Postoperative or posttraumatic arthro fibrosis of the knee occurs in patients who have had the knee immobilized for a prolonged period, resulting in severe compromise to knee function. The femoral artery passes into the popliteal fossa approximately 10 cm above the knee joint.

The patello femoral joint is part of the quadriceps mechanism,the patella is anchored distally to the tuberosity of the tibia by the patellar tendon superficially to the tendon of quadriceps muscle, and by medial and lateral retinacula to knee joint capsule. The patella increases the leverage of the quadriceps muscle.

The Attachments on the lateral condyle are

a) The **fibular collateral ligament** of the knee joint.

b) The **popliteus tendon**

c) The **lateral head of gastrocnemius**.

The Attachments on the medial condyle are

a) The **tibial collateral ligament** of the knee joint.

b) The adductor tubercle at lower end of medial supracondylar line receives the **insertion of hamstring part(ischial head) of adductor magnus.**

c) Medial head of gastrocnemius

The Attachments on the intercondylar notch

a) ACL is attached to the posterior part of the medial surface of the lateral condyle.

b) PCL is attached to anterior part of lateral surface of the medial condyle.

c) The intercondylar line provides attachment to the capsular ligament and laterally to the oblique popliteal ligament. The anatomic axis of knee joint has a valgus angulation of 9 degrees.

Nutrient Artery to femur

This is derived from the second perforating artery. Nutrient foramina is located on the medial side of the linea aspera and is directed upwards. There is no artery entering distal femur, but has abundant blood supply through genicular vessels, of which the middle genicular supplies the cruciate ligaments.

Ossification

Excepting the clavicle,the femur is the first long bone to ossify. Femur ossifies from **1 primary and 4 secondary centres**. The primary centre for the shaft appears in 7^{th} week of I.U. life. The secondary centers appear,one for lower end at the end of 9^{th} month of I.U. life. This is the major growing end of the bone. A center appears in head during first six months of life, one for greater trochanter during 4^{th} year and one for lesser trochanter during 12^{th} year .There are three epiphysis at the upper end and one epiphysis at lower end, that fuses by the 20^{th} year. Patella ossifies from several centres which appear during 3-6 years of age, fusion complete at puberty.

CLASSIFICATION OF DISTAL FEMORAL FRACTURES

Fractures of the distal femur involve distal 9-15cms of the femur including the distal femoral metaphysic (supracondylar) and the articular surface of the distal femur (intercondylar).

A good classification system for fractures of distal femur should:

1. Distinguish among the many possible injuries to this area, including extra articular, intra articular and isolated condylar lesions.
2. Allow different surgeons consistently and reliably to grade a fracture pattern into one of the classification groups.
3. Assist in deciding the optimal method of treatment for the injury.
4. Correlate with the findings of outcome analysis to allow estimation of prognosis for each injury pattern.

NEER classified into 3 groups, but did not take in to account associated intra articular fractures and the possibility of articular incongruity.

Group I:

Minimum displacement, impacted, linear or slightly displaced, but stable after closed reduction.

Group II A:

Condyles displaced medially, violent force applied to the anterolateral aspect of the flexed knee, oblique fracture extending from just proximal to the lateral epicondyle to well above the medial epicondyle.

Group II B:

Condyles displaced laterally, severe force applied to the lateral side of the extended limb;the shaft is displaced medially , and when the fracture is open,it penetrates the skin on the inner aspect of thigh,spares extensor tendon.

Group III:

Combined supracondylar and shaft fractures,high energy trauma to the anterior of the flexed knee, when open , penetrates the skin superior to patella.

SEINSHEIMER CLASSIFICATION

Into four type addressing articular disruption.

Type 1: Nondisplaced fracture or those with less than 2 mm of displacement

Type 2: fractures involving the distal metaphysis only, without intra articular extension.

a) Two part

b) Comminuted

Type 3: Fractures involving the inter condylar notch in which one or both condyles are separate fragments

a) Medial separate

b) Lateral separate

c) Both condyles separated from the shaft and from each other

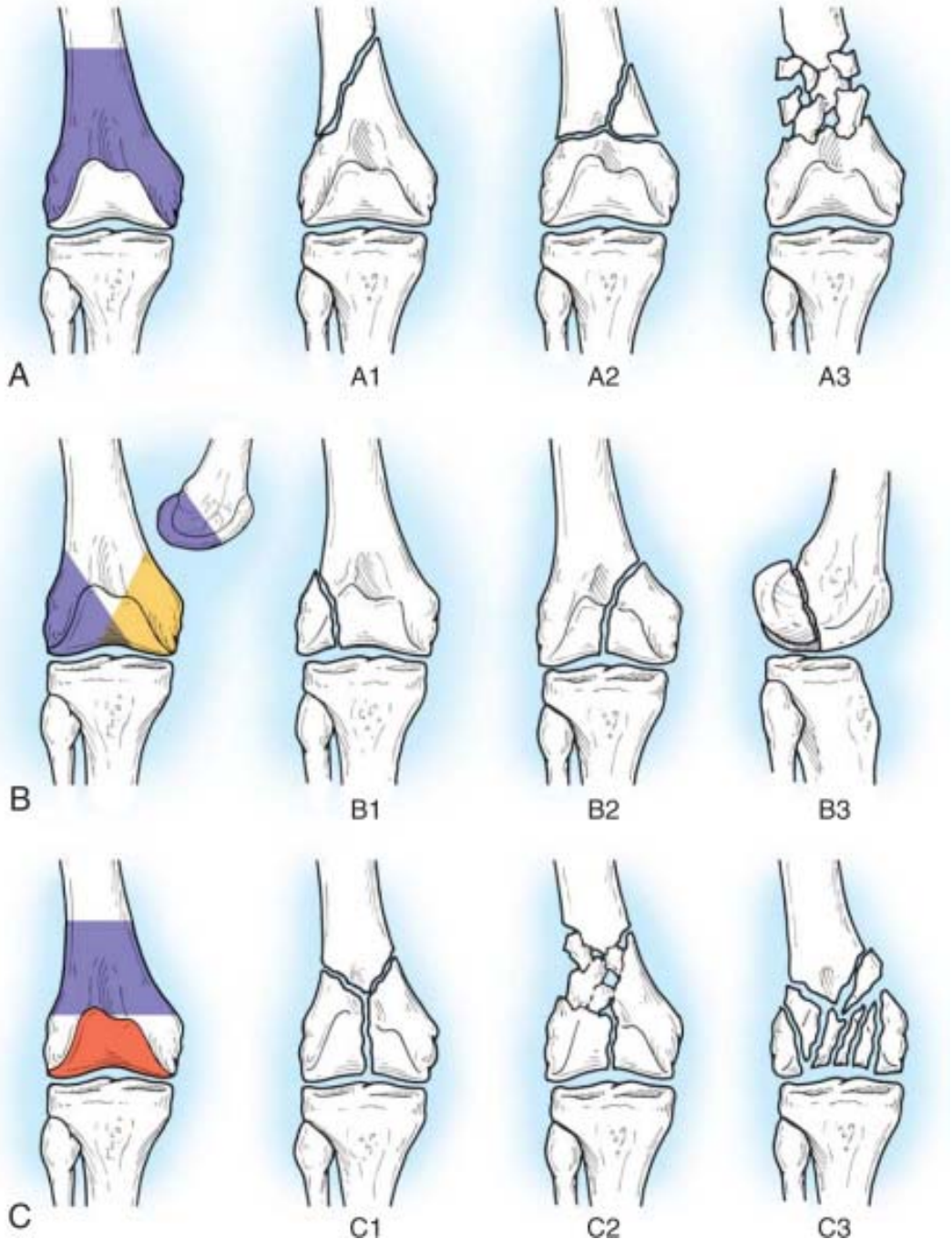
Type 4: Fractures extending through the articular surface of a femoral condyle.

a) Through medial condyle (two –part or comminuted)

b) Through lateral condyle (two part or comminuted)

c) Complex and comminuted

CLASSIFICATION



ORTHOPAEDIC TRAUMA ASSOCIATION CLASSIFICATION OF DISTAL FEMORAL FRACTURES (OTA) DEVELOPED BY MULLER[23]

Defines the fracture extra – or – intra articular,comminution , indicates prognosis, and helps to decide the type of treatment.

Type A: Extraarticular

A1: Simple (two part)

A2: Metaphyseal Wedge

A3: Metaphyseal complex (comminuted)

Type B: Unicondylar , partial articular

B1: Lateral condyle, sagittal

B2: Medial condyle, sagittal

B3: frontal (coronal plane)

Type C: Intercondylar/ bicondylar, complete articular

C1: Articular simple, metaphyseal simple

C2: Articular simple, metaphyseal complex

C3: Multi fragmentary articular fracture

Descriptive Classification[24]

- Open Vs Closed
- Location – supra condylar , inter condylar involvement
- Pattern - Spiral, oblique, or transverse
- Articular involvement or not
- Angulation - Varus, Valgus or rotational deformity
- Displacement – shortening or translation
- Comminution , segmental , or butterfly fragment

We followed OTA classification developed by Muller[23] because of **its simplicity, reproducibility and wide acceptance among the orthopaedic surgeons.**

MECHANISM OF INJURY IN DISTAL FEMUR FRACTURES

The mechanism of injury in most cases is axial loading with Valgus or varus or with rotational forces[1.2].The force acting over the distal femur also produces fractures. The deformities are produced primarily, by the direction of the initial fracture displacement and secondarily , by the pull of the thigh muscles. Pull of the hamstrings and quadriceps lead to limb shortening and angulations at the fracture site[23,24]. Adductor mucles produce varus

deformity, contraction of the gastrocnemius muscle produces posterior angulation. In fractures with intercondylar extension, muscle attachments to the respective condyles tend to produce splaying and rotational malalignment. Open fractures occur in 5-10% of all supracondylar fractures. The most common site for the open wound is over the anterior thigh proximal to the patella.

High energy: Young patients sustain injury after high energy,

Ex: motor vehicular trauma.

Low energy: Elderly patients may sustain fractures through osteoporotic bone, after relatively minor trauma, such as a fall onto a flexed knee. Varus/ valgus stress forces with axial load and rotational components play a significant role in producing these fractures.

In our study, 12 out of 20 cases resulted from road traffic accidents, 5 cases due to fall from height and the rest due to trivial injury in osteopenic bone.

CLINICO – RADIOLOGICAL EVALUATION

A detailed history should be taken, to ascertain the mode of violence and to correlate the fracture pattern and to anticipate hidden complications. This being followed by a detailed full trauma evaluation. About 1/3 rd of younger patients are polytraumatised and in only one fifth of cases, present

as isolated injury. Vascular lesions are found in about 3% cases and nerve injuries in about 1%.Lesions of menisci and Osteochondral fractures are observed in 8-12%,while associated fracture of patella in approximately 15%[23,24].

Pateints may typically present non ambulatory with pain and variable deformity in the supracondylar region of the femur. Gross mobility may be present at the fracture site with crepitus. Immediate assessment of neurovascular status is mandatory. The proximity of neurovascular bundles to the fracture site is an important consideration. Any unusual and tense swelling in the popliteal area and the usual signs of pallor and lack of pulse suggest rupture of a major vessel; in these cases, angiography may be necessary.

Any Clinical suspicion of compartment syndrome, must be followed by monitoring compartment pressures and assessing hemodynamic instability. Examination of ipsilateral hip, knee, leg and ankle, leg and ankle, are warranted, especially in the obtunded or polytraumatized patient.

In cases in which a distal femoral fracture is associated with an overlying laceration or puncture wound, saline or methylene blue may be injected into the knee in a sterile fashion to determine continuity with the wound.

Radiographs

Anteroposterior, lateral and two oblique radiographs of **a**ffected extremity should be taken. Traction views may be helpful 45 degree oblique views can better delineate intercondylar involvement[23,24]. Radiographic evaluation of the entire involved lower extremity is warranted, as concomitant injuries are common.

- Contra lateral views may help with comparison and may serve as a template for preoperative planning.
- Computed tomography portrays the distal femur in cross – section, which helps to identify fracture lines in the frontal plane. Two and three dimensional reconstructions may also improve understanding of the fracture pattern in preparation for surgery.
- Angiography is indicated with frank dislocation of the knee as 40% of such injuries associated with vascular disruption. By contrast, the incidence of avascular disruption with isolated supracondylar fractures is between 2% and 3%.

METHODS OF TREATMENT

Non operative

May be useful under following circumstances

1) Non displaced or incomplete fractures.
2) Impacted stable fractures in elderly.
3) Osteoporotic patients
4) Infected or severely contaminated fractures grade IIIb/IIIc open injuries)
5) Advanced osteoporosis.
6) Advanced underlying medical complications.
7) Select gunshot injuries.

- The objective is not absolute anatomic reduction by rather restoration of the knee joint axis to a normal relationship with the hip and ankle. Good to excellent results of 84% using closed methods were reported by **Neer.**
- Reduction can be obtained by application of traction placed through a **two-pin system -** one through the tibial tuberosity. But the difficulties are, the inability to control the displaced intraarticular fragments and

occasionally, the tendency of the supracondylar fragments to displace posteriorly. The potential drawbacks include varus and internal rotational deformity, knee stiffness, and the necessity for prolonged hospitalization and bed rest.

- After initial skeletal traction period 6-12 weeks, functional Bracing can be advised.

Operative Treatment[23, 24]

When there is a displaced intraarticular fractures and irreducible fractures with severe comminution.

Relative indications include displaced extra articular fractures, periprosthetic fractures, marked obesity and pathological fractures.

The choice of implant is governed by operative goals. The goals are restoration of length and axial alignment both anatomic reduction and articular congruity, stable fixation and early functional rehabilitation.

Treatment options include.

1) **95 degree condylar Blade plate**

Ideal for supracondylar fractures

It is one piece device that can provide stable internal fixation. Also superior results are produced by using indirect reduction technique by A.O

distractor, without visualising the fracture line. It provides better healing, optimal alignment and stability and precludes bone grafting .But it is a technically demanding procedure, because the surgeon is required to place the blade plate in 3 planes simultaneously.

2) **Condylar Butteress plates**

It is used, when severe comminution exists in lateral femoral Condyle or there are multiple intra-articular fractures in coronal and sagittal planes.

3) **Intramedullary fixation**

Indicated for supracondylar fractures, Zickel supracondylar nail provides good fixation in non comminuted fractures. Retrograde Interlocking Intramedullary nailing modified by savalary et al, from hungary avoids open reduction, permits, early mobilization & wait bearing and nail can be left in the place because no stress shielding.

4) Dynamic condylar Screw [19,23]

Allows inter fragmentary compression for intercondylar femur fractures, but bulky at screw-plate junction, thus requiring considerable bone removal for low profile fit. A minimum of 4cm of distal femur is necessary so that sufficient bone is available for condylar screw insertion. A distal biock of medial condyle is also required. Successfully used in supracondylar-intercondylar fractures types (C1 and C2).

5) External fixation

It may be used alone or with limited internal fixation as follows: Grade I,II,IIIa Injuries can be managed with internal fixation after aggressive debridement and irrigation. Grade IIIb and IIIc injuries should be managed with debridement, External fixation followed by delayed internal fixation. Problems include pin-tract infection, quadriceps scarring, delayed union or non union and loss of reduction after device removal. Ilizarov fixator can also be used.

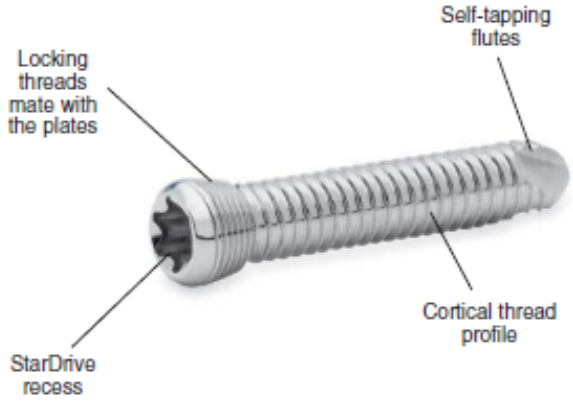
6) Locking Compression Plates(Condylar)[10,17,18,20,23,24]

Combi hole plates combines the advantages of the dynamic compression plate principle with the locking screw head principle, giving the surgeon great flexibility of choice within a single imp.

The screw holes in plate have been specially designed to accept either a standard cortical screw with hemispherical head or a locking screw with a threaded head. The locked screws also eliminated the need for fixed angle blade plates in the metaphyseal area. A locked screw plate construct can be compared to an implanted external fixator. **In traditional plating**, stability is produced by compressing the plate bone surface and engaging both cortices thereby producing a rectangular hoop with two screws. Their stability primarily depends on the friction between the plate and the bone[4,6].

4.0 mm and 5.0 mm Locking Screws, self-tapping, with StarDrive recess

The locking screws mate with the threaded plate holes to form a fixed-angle construct.



The Locking Condylar Plate

In locking plates[25], the periosteum is not compressed and blood supply of bone is preserved. The locking of the screws into the plate prevents the loss of reduction primarily, at the time of fixation and also after fixation, because the **toggles of screw are avoided**. **The frictional force between the plate and the bone is eliminated**. Also, there are provisions to put screws in different angles at the metaphyseal area further improving the stability of construct. The locking plates are fixed angle devices, prevent **Varus collapse,** and **prevent toggle** and sequential screw loosening, particularly in osteoporotic bone[13.]

In the locking system, the forces are distributed evenly over the entire contact surface of the screws in the bone and are transmitted through the contact points of the plate with bone surface. The first screw next to the fracture transmits about 50% to 60% of the forces, the second 20% to 30% and the third screw about 10% Load transmission by additional screws is negligible.

The condylar locking plates for femur has side differentiation & comes in precontoured and variable hole design and the combi-hole increasing its versatility and can be used in severely comminuted extra and intra articular fractures.

The disadvantages with locking plate device are that,

1. Current locking plate design **maintains fracture reduction but does not obtain it.**

2. The surgeon has no **tactile** f**eedback as to the quality o**f **bone,** when tightening the screws because the screws stop abruptly when threads are completely seated into the plate regardless of bone quality.

3. Locked screws on its own will not pull the plate down to bone; hence this **lack of construct reduction capability** , combined with percutaneous plating techniques , can result in higher rates of fracture malalignment than that occur with formal open reduction and internal fixation.

4. Another concern is the **rigidity of a locked screw plate construct**. Any fracture distraction at the time of reduction or fracture resorption during healing will be held rigidly by such constructs which prevent bone to bone contact and may potentially result in delayed union or non union.

5. **No Load sharing** can occur with locked screws on either side of a fracture .If the fracture is repetitively loaded, the plate eventually may fracture or fixation may be lost.

6. Some locking plate designs **do not allow the angling of the screws** by the surgeon within the hole and still achieve a locked screw.
7. **Contouring locked plates distort the screw hole** and adversely affect the screw purchase.
8. **Hardware removal may be more di**fficult, if locked become cold welded to the plate.

DESIGN FEATURES OF LOCKING COMPRESSION PLATES

- **50** degree of longitudinal screw angulations
- **14** degree of transverse screw angulations
- Uniform hole spacing
- Load(compression) and neutral screw positions
- Plates are made of 316 stainless steel
- Tapered end for submuscular plate insertion, improving tissue viability.
- Limited – contact plate design reduces plate to bone contact, limiting vascular trauma.

Locking screw design

The screw deign has been modified from standard 4.5mm screw cortex to enhance fixation and facilitate the surgical procedure. New features include;

- **Conical screw head:** To provide the secure screw plate construct.
- **Large core diameter:** Improve bending and shear strength and distributes the load over a larger area of the bone.

Cortical thread profile: The shallow thread profiles of the locking screws results from the larger core diameter. **Features**

- ❖ Locking screws engaged in the plate create fixed – angle construct that improves fixation in osteopenic bone and multi fragment fractures
- ❖ Multiple screw fixation in the femoral condyles.
- ❖ Low-profile, anatomically – shaped plates designed for left or right femur.
- ❖ 316L stainless steel implants.

Plate Head (condylar region)

- Anatomically – shaped head is contoured to match the distal femur , eliminating intra operative plate contouring
- Six threaded screw holes accept locking screws.

Plate shaft

- Combi holes combine a dynamic compression unit (DCU) hole with a locking screw hole, providing the flexibility of axial compression and locking capability throughout the length of the plate.
- Straight plates available with 6,8,10,12,14,16 or 18 Combi holes in plate shaft to accommodate fracture patterns that include shaft fractures in conjunction with articular fragments.
- Curved plate are precontoured to mimic the anterior bow from the lateral aspect of the femur.
- Limited – contact design –plate shaft design permits use of a minimally invasive surgical technique.

GENERAL PRINCIPLES OF INTERNAL FIXATION USING LC-DCP (COMBI HOLE PLATES) [12, 17]

- Internal fixation done, using a combination of locking and standard screws.
- If a combination of cortical and locking screws is used, a cortical screw should be inserted first to pull the plate to the bone.
- If locking screw have been used to fix a plate to a fragment, subsequent insertion of a conventional screw in the same fragment without loosening and retightening the locking screw is NOT RECOMMENDED.
- If a locking screw is used first, care should be taken to ensure that the plate is held securely to the bone to avoid spinning of the plate about the bone.
- Dynamic compression: Once the metaphyseal fragment has been fixed with locking screw, the fracture can be dynamically compressed using conventional screws in the DCU portion of the LCP hole.
- First use lag screws to anatomically reconstruct the joint surfaces.
- A plate used as a locked plate does not produce any additional compression between the plate and the bone.
- The unicortical insertion of a locking screw causes no loss of stability.

Depending on the desired function the locking compression plate (LCP) can be applied in three different ways [12,17];

1) As a conventional dynamic compression plate providing absolute stability (**compression technique).**
2) As a pure internal fixator providing relative stability by bridging the fracture zone according to LISS principles (**bridging technique).**
3) In combined fashion where both technique are employed (**combination technique)** using conventional lag screws as well a locked screws.

❖ **SURGICAL TECHNIQUE FOR FIXING DISTAL FEMUR FRACTURES**

Although various approaches like

1) Lateral – standard
2) Minimally invasive lateral approach,
3) Medial Approach,
4) Antero – lateral approach are described

Most surgeons prefer to use Lateral approach – standard

SURGICAL TECHNIQUE

Patient position

Patient is positioned supine with sandbag under ipsilateral buttock to allow slight internal rotation of the leg. The leg should be draped free, the iliac crest should be prepared and draped, if bone grafting is desired. Alternatively, patient may be placed in lateral position, based on surgeon's comfort.

Prerequisites

- A radio –lucent operating table facilities the use of an image intensifier during the procedure.
- Avoid using fracture table and traction because the resulting muscle tension will make exposure and reduction more difficult.
- Place a sterile bolster under knee to facilitate exposure and reduction. A sterile tourniquet may be used as a part of procedure.

In lateral approach, a single straight lateral incision is made along the thigh. Distally, the incision should extend across the midpoint of the lateral condyle anterior to fibular collateral ligament, across knee joint and then gently curve anteriorly to end distal and lateral to tibial tubercle.

Then, fascia lata is incised

- Superior geniculate artery is indentified and ligated
- Care should be taken not to incise the lateral meniscus at the lateral joint margin.
- The vastus lateralis muscle carefully elevated from intermuscular septum and retracted anteriorly and medially.
- Osteotomy of tibial tubercule & lifting along with patellar tendon, improves anterior exposure to the condyles of femur.
- In modified approach by starr et al, an anterolateral skin incision is made and lateral parapateller arthrotomy with elevation of vastus allows better visualization of the condyles.

OPERATIVE STEPS

- Reduce and temporarily secure the articular fragments with pointed reduction forceps and /or K wires. If a Posterior Hoffa fragment is present, it must be reduced and provisionally stabilized with K wire inserted from anterior to posterior.
- Secure the condyles with 6.5 mm cancellous screws. A condylar plate guide or plate itself may be held laterally on the condyle to select an area, where screws will not interfere with plate placement

- Place a K wire across the femoral condyle, at the level of the knee, to indicate the joint axis and place a second K wire across the patella – femoral joint on the trochlear surface.
- Using anatomic landmark and C – arm imaging, mount the plate on the intact / reconstructed condyle without attempting to reduce then proximal portion of the fracture. It is easier to thread the wire guides into the plate prior to placing the plate on the bone.
- Check whether the guide wire inserted in through the central hole is parallel to both distal femoral joint axis and patella femoral joint.
- Measure the length using measuring device. Insert screws starting from central hole in the condylar and check under image control.
- Self Drilling, self tapping flutes of the screws make pre drilling /pre tapping unnecessary in most cases. In dense bone, lateral cortex may be predrilled.
- Once reduction was satisfactory, the plate shaft was fixed with appropriate cortical screws after confirming final reduction of the fracture.

POST OPERATIVE CARE AND REHABILITATION[12, 15]

Proper postoperative rehabilitation is essential to ensure the attainment and maintenance of satisfactory range of motion, strength and function of the knee joint.

Rehabilitation should be custom made to the patient and the fracture type, and is easier, more comfortable and more assured with firm internal fixation. If fracture fixation is stable, then therapy can be started earl y. The most useful range of motion can be the first few weeks of postoperative period.

Early phase (1-3 Weeks)

The primary goal is full range of motion, started on 2nd day, if fixation is stable, emphasizing extension, normal patella mobility, control of edema and pain.

- ★ Quadriceps strengthening and hamstring exercises are encouraged.
- ★ Gentle hip ankle mobilization exercises are continued.

Continuous passive motion - when started in 1st week has following advantages

1. Improves early range of motion of knee.
2. Decreases incidence of deep vein thrombosis and pulmonary embolus.

3. Faster pain relief and shorter stay at hospital.
4. Better results when used at a rate of 1 cycle per minute, with 40 degrees of maximum flexion for first 3 days.
5. Continuous passive motion reverses collagen loss, improves cartilage nourishment, and prevents joint stiffness.

★ Non – weight bearing with crutches or walker support can be initiated in 1st week, if fixation is stable.

★ Sutures are removed between 10th -12th postoperative days.

Late Phase (After 3 weeks)

★ Continue isometric quadriceps setting exercises, Active and passive Range motion exercises.

★ Seated knee extension procedures.

★ Partial weight bearing is allowed after 3rd week.

★ Full weight bearing is allowed after radiological evidence of healing (6-12 weeks)

Patients with inter condylar fractures and A-0 types B and C fractures are not allowed full weight bearing for at least 12 weeks.

GOALS OF REHABILITATION

- Based on the observation that 65 degree – 70 degree flexion is required in the swing phase of normal gait, 90 degree knee flexion required to ascend and descend stairs and 105 degree flexion required to raise early from a low chair and to tie one's shoes[2,2]. Most recommend continuous passive motion for 3 hours daily for 2-3 weeks, till the patient achieves more than 100 degree flexion.

- Periodic monitoring of knee flexion at end of 1st ,2nd,3nrd,week and after completion of therapy, with concomitant isometric quadriceps exercises and knee mobilization exercises

MATERIALS AND METHODS

MATERIALS AND METHODS

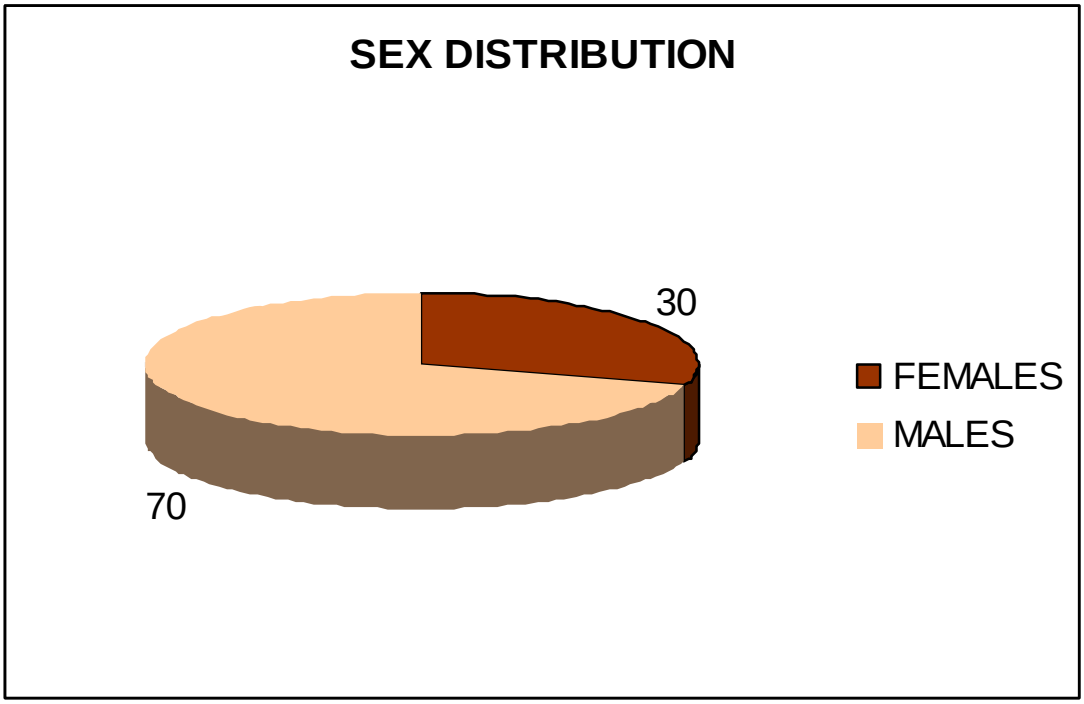
This prospective study is an analysis of functional of 20 cases of displaced distal femoral fractures, internally fixed using locking compression condylar plates, which was undertaken at the department of orthopedics and traumatology at Government Royapettah Hospital, Chennai from July 2008 to October 2009.The Government Royapettah Hospital, is a multi specialty tertiary care referral and trauma centre with an average bed strength of about 700 and 110 beds allotted for orthopaedics and is situated in the heart of the city. We have a 24 hours emergency casualty, running all 365 days a year and fully equipped to take both medical and surgical emergencies, with emergency operation theatre.

In our study of the 20 patient 13 were males, 7 were females (Table -1)

Table I

SEX DISTRIBUTION

S. No.	Sex	No of Patients	Percentage (%)
1	Males	13	70
2	females	7	30



AGE DISTRIBUTION

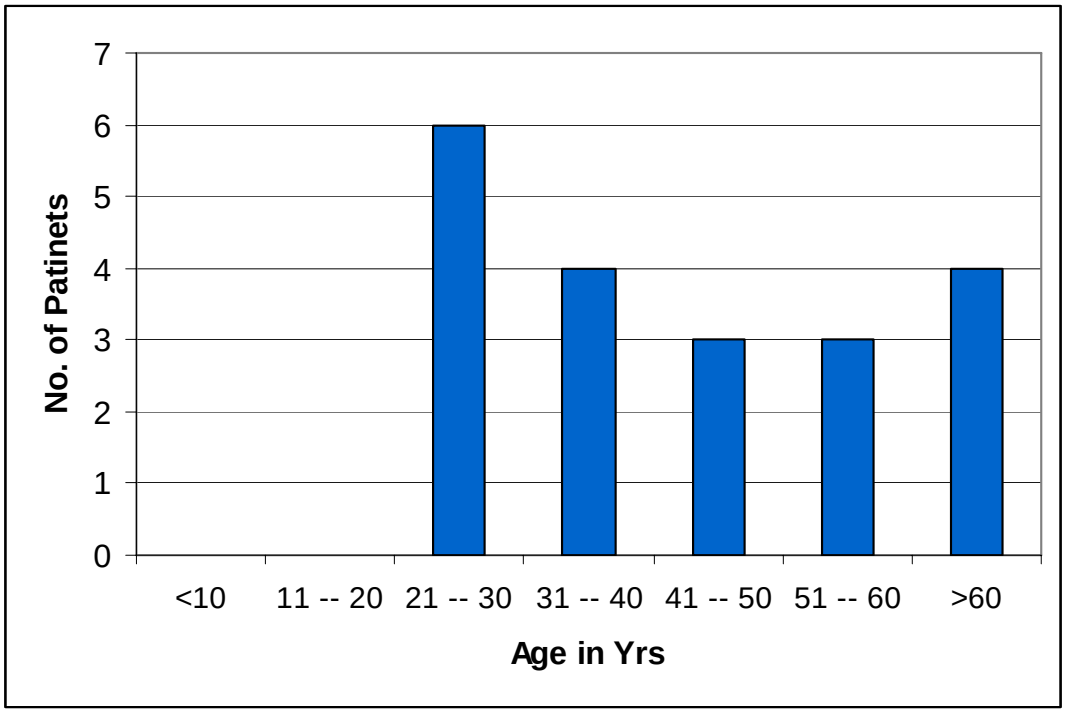
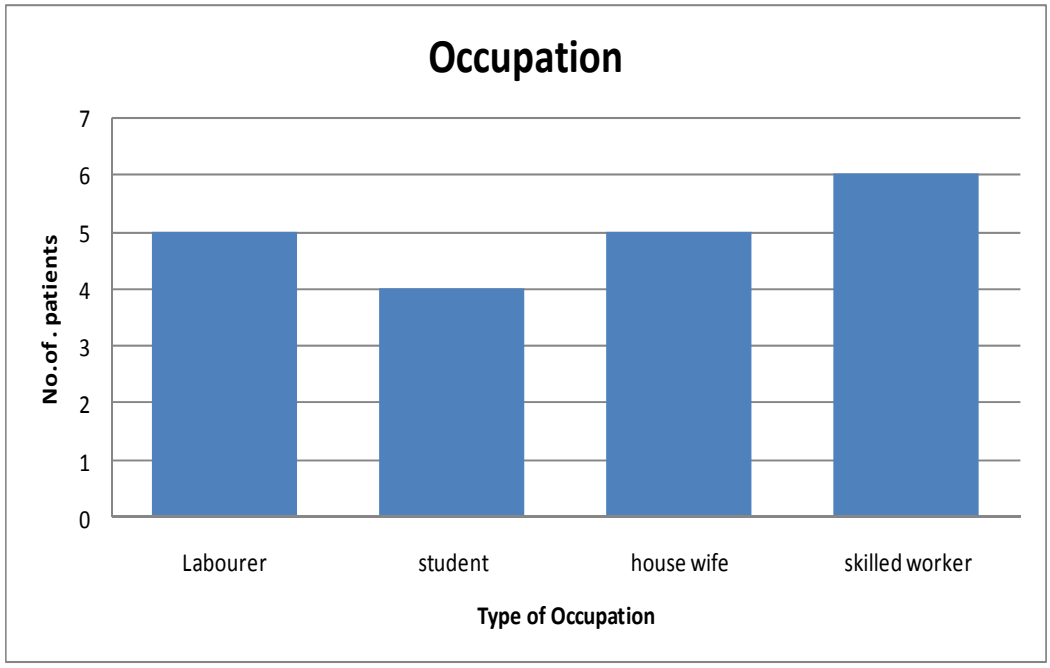


Table II

AGE DISTRIBUTION

S. No.	Age group	No of Patients	Percentage (%)	Males	females
1	0-10	0	0	0	0
2	11-20	0	0	0	0
3	21-30	6	30	6	0
4	31-40	4	20	3	1
5	41-50	3	15	2	1
6	51-60	3	15	1	2
7	61-70	4	20	1	3

The mode of injury was road traffic accident in 12 Patients (60%) fall from height in 5 patients (25%) and other mode in 3 patients (15%).


Occupation
No.of. patients
7
6
5
4
3
2
1
0
Labourer
student
house wife
skilled worker
Type of Occupation

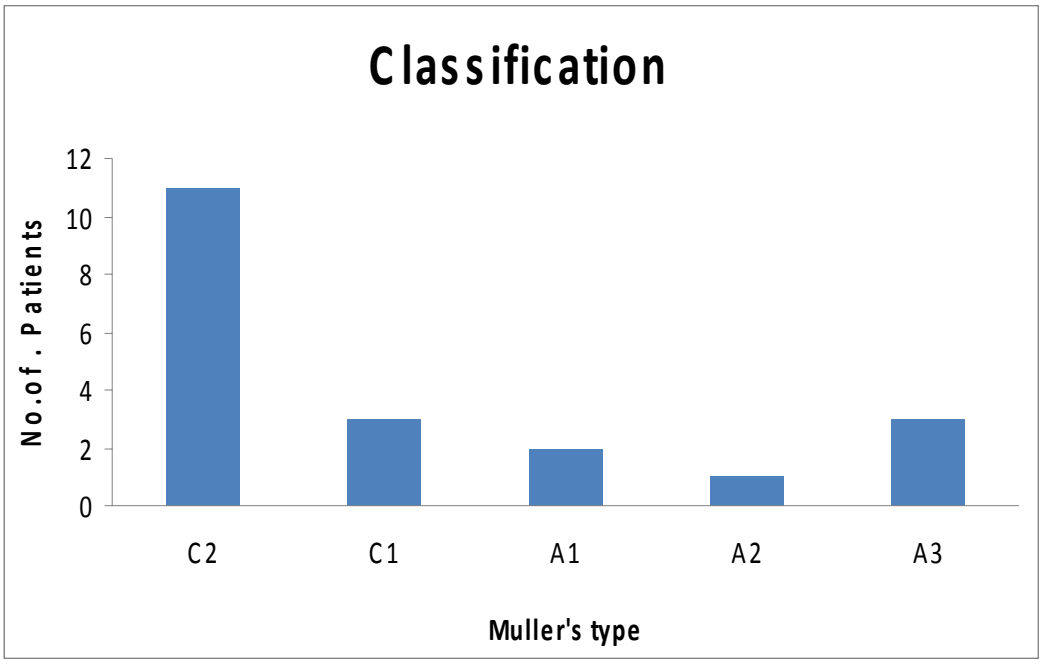

Classification
No.of. Patients
12
10
8
6
4
2
0
C2
C1
A1
A2
A3
Muller's type

Table III

OCCUPATION

S. No.	Occupation	No of Patients
1	Labourer	6
2	Student	2
3	House Wife	5
4	Skilled worker	4
5	Business	3

Table IV

SIDE OF AFFECTED LIMB

S. No.	Side involved	No. of Patients
1	Right Limb	5
2	Left Limb	15

- 12 patients presented to us within one week after injury, 8 patients came to us after two weeks.
- Meticulous clinical examination was made in all patients and associated injuries were treated with proper documentation.

Table V

ASSOCIATED INJURIES

S. No.	Associated Injuries	No. of Patients
1	Distal Radius fracture	2
2	Metatarsal fracture	2
3	patella fracture	1
4	Tibial shaft fracture	1

Table VI

FRACTURE CLASSIFICATION

S. No.	Fracture Classification Distal femur MULLER'S	No. of Patients
1	C2	11
2	C1	3
3	A1	2
4	A2	1
5	A3	3

Table VII

CLOSED Vs OPEN FRACTURE

S. No.	Fracture	No. of Patients	Percentage (%)
1	Closed	20	100
2	Open	0	0

Standard antero-posterior, lateral and oblique radiographs of the affected extremity were taken covering the distal femur with knee. Further evaluation included, radiographs of whole of the hip with thigh (affected) and x-ray pelvis both hip A.P and x-ray of ipsilateral leg A.P & LATERAL. Any other relevant x-rays were ordered accordingly. CT scan was done in 2 patients who had severe intra articular comminution,to delineate the fracture line and pattern of involvement, with position of the fragments[6,7].

All patients with displaced, comminuted fractures and medially fit were subjected to surgery which consisted of open reduction and internal fixation with locking compression plate without autogenous bone grafts.

OPERATIVE STEPS

Under appropriate anaesthesia, we used the standard lateral approach to distal femur, with patient in supine position and a sand bag was kept below the operating knee and one below the ipsilateral hip.

- Skin and subcutaneous tissue were cut, the fascia lata was incised, and superior geniculate vessels were isolated. All bleeders were cauterized, later using bone spikes the fracture site was reached and the articular fragments were reduced temporarily with pointed reduction forceps and/or K wires.
- We secured the condyles with 6.5 mm cancellous screws. A condylar plate guide or plate itself was held laterally on the condyle to select an area where screws will not interfere with plate placement.
- Then a K wire was placed across the femoral condyle,at the level of the knee to indicate the joint axis and place a second K wire across the patella femoral joint on the trochlear surface.
- Using anatomic landmarks and C – arm imagining, we mounted the place on the intact -/reconstructed condyle without attempting to reduce the proximal portion of the fracture.

- Final check was made us to, whether the guide inserted in through the central hole was parallel to both distal femoral joint axis and patella femoral joint.
- Screw length determined using measuring device. Screws inserted starting from the second hole in the condylar portion and was checked under image control and subsequent screws were inserted.
- Once reduction was satisfactory, the plate shaft was fixed with appropriate cortical screws after confirming final reduction of the fracture.

Postoperative care and Rehabilitation

- Post operative care in the form of intravenous antibiotics and periodic change of dressings were done. The suction drain was removed after 48 hours, and sutures were removed at 12^{th} postoperative day.
- Rehabilitation was custom made to each patient and gentle knee mobilization was started on 3^{rd} postoperative day, emphasizing quadriceps strengthening and hamstring stretching exercises and gentle hip and ankle mobilization were started.
- Continuous passive motion was advised for elective cases, who had presented late and had knee stiffness earlier. We recommended at a rate of one cycle/minute, with 40 degrees of maximum flexion, for first 1 week.

- Non weight bearing with walker support was started at the end of the first week.

- Full weight bearing was allowed only after radiological evidence of union[20].

- All patients were treated at regular intervals and evaluated for fracture healing and any changes in alignment, screw breakage were monitored. Femoral alignment was assessed by measuring the angle created by a line drawn along the femoral shaft and one drawn parallel to the femoral condyles, with 5 degree of valgus considered to be normal. The lateral radiograph was evaluated for procurvatum or recurvatum with use of lines drawn along the main fragments[17, 20].

- **Clinical union was** defined as a painless fracture site during full weight – bearing[17,20].

- **Radiographic union** was defined as bridging trabeculation across the fracture line(s) on three of four cortices seen on orthogonal projections in absence of migration, loosening, or breakage of hardware[17,20]. **Functional outcome was measured using Neer et al, functional scoring system[1, 3].**

OBSERVATIONS

OBSERVATIONS

- Majority of injured patient were males (70%)
- Highest numbers of patients were in their third decade (35%)
- Road traffic accident was the most common mode of injury.
- There was not a single case with bilateral fractures.
- 2 patients had associated distal radius fracture , 2 patients had ipsilateral metatarsal and phalangeal bones fracture, one patient had ipsilateral tibial condyle and one patient had ipsilateral tibial shaft fracture making a total of 6 patients(30 %) with associated fractures
- Most of the patients, reported within 1st week of injury to the hospital.
- All 20 patients had closed injury.
- Type C2 muller's fracture was the most common fracture type 11 out of 20 patients (55%).
- The shortest follow up period was 3 months and the longest follow up period was 15 months.
- The average range of knee flexion achieved was about 92 degrees
- Maximum gain in knee flexion was 110 degrees and minimum gain about 80 degrees.

- The average knee score 80.55% was rated using NEER functional score.
- Early complications were encountered in 4 patients and these were superficial wound infection and mild transfusion reaction.
- Late complications were observed like mal- union with varus in 4 patients, screw breakage in 1 patient, knee stiffness in 2 patients.
- The average stay in hospital was about 14 days.
- Postoperative immobilization with knee brace was advised for severely comminuted fractures, for weeks, although gentle physiotherapy exercises were started earlier.
- Bone graft was not used in any of the patient.

RESULTS

RESULTS

- All patients were followed at regular intervals(i.e., once in a month for the first 3 months and once every 3 months thereafter)
- The minimum follow up period was 3 months and the maximum follow up was 15 months. The mean follow up period in this study was 8.46 months

The results were evaluated by taking into consideration the following factors

1. Pain
2. Function
3. Motion
4. Work
5. Gross Anatomy and
6. Roentgenograms

NEER'S FUNCTIONAL SCORING was used to assess the outcome of surgery, for adult distal femoral fractures[1,3,]. It consists of:

Functional (70 units) and Anatomic (30 units)

Table 1

Pain (20 units)	Unit Value
5-No Pain	20
4-Intermittent	16
3-With fatigue	12
2-Restrict function	8
1-0 constant or at night	4-0

In our observation, 10 out of 20 patients had no pain (50%), 6 patients had intermittent pain due to knee stiffness (30 %), 4 patient had pain with fatigue, (20%).

Table 2

Function (20 Units)	Unit Value
5-As before injury	20
4-Mild restriction	16
3-Restricted,stairs sideways	12
2-Cane or severe restriction	8
1-0 Crutches or brace	4-0

In our study, 12 out of 20 patients were able to return to their function as before injury. Mild restriction was noted in rest of 6 patients, restriction with stair climbing in 2 patients.

Table 3

Motion(20 units) Knee Flexion	Unit Value
5-Normal or 135 degrees	20
4-100 degrees	16
3-80 degrees	12
2-60 degrees	8
0-20 degrees or less	0

In our observation, 10 out of 20 patients gained knee flexion of 100 degree or more, 2 patients gained up to 90 degree and Remaining 8 patients averaged a knee flexion of 80 degree

Table 4

Work (20 Units)	Unit Value
5-As before injury	10
4-Regular but with hand slip	8
3-Alter work	6
2-Light work	4
1-0 No work	2-0

In our observation, 12 patients worked as before injury,4 patients with mild handicap and 4patients to alter work.

Table 5

Gross Anatomy(15 Units)	Unit Value
5-Thickening only	15
4- 5 degrees angulations or 0.5 cm short	12
3- 10 degrees angulations or rotation,2.0 cms short	9
2- 15 degrees angulations or rotation,3.0 cms short	6
1- union but with greater deformity	3
0- non union or chronic infection	0

In our study, 4 patients developed mild varus angulations of 5 degree and another 4 patients had 10 degree varus with shortening subsequently (2 cms), and the remaining patients had thickening only.

Table 6

Roentgenogram (15 Units)	Unit Value
5- Near Normal	15
4- 5 degrees angulations or 0.5 cm displacement	12
3- 10 degrees angulations or 1.0 cm displacement	9
2- 15 degrees angulations or 2.0 cms displacement	6
1- union but with greater deformity; spreading of condyle; osteo-arthritis	3
0- non union or chronic infection	0

Out of 20, 12 patients had near normal radiographs, 4 had 5 degrees angulations and another 4 points had 10 degrees angulations.

Table 7

Overall Rating

Excellent	**Above 85 Units**
Satisfactory	70-85 units
Unsatisfactory	55-69 units
Failure	Below 55 units

Overall results were excellent in 9 out of 20 cases and were good satisfactory in remaining cases. The overall average knee score in our study was 80.55%[1, 3].

CASE ILLUSTRATIONS

CASE - I

Name	:	**Senthil 22/M**
Mode of Injury	:	RTA
Extremity	:	Left
Diagnosis	:	C 2 closed
Pre op	:	7 days
Procedure	:	ORIF with LCP
Post op period	:	Unevent ful
Non-weight bearing mobilisation	:	5 days
Partial weight bearing	:	12 weeks
Full weight bearing	:	16 weeks
At follow up	:	13 months
Knee flexion	:	0-90
NFKS	:	86
Result	:	Excellent

CASE - I

PRE OP AP

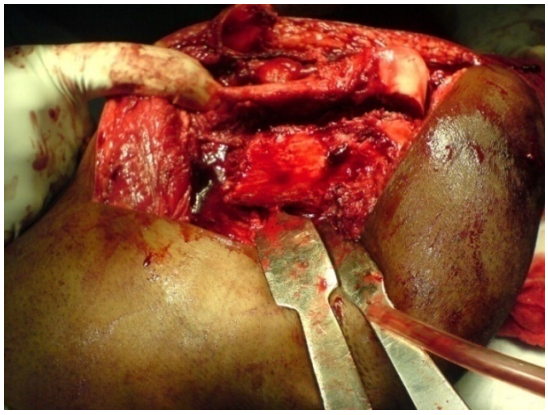
PRE OP LAT

POSTOP AP

POST OP LAT

CASE - I

INTRA OP



3 MONTHS AP

3 MONTHS LAT

CASE - II

Name	:	**Kuppammal 65/F**
Mode of Injury	:	Fall from height
Extremity	:	Right
Diagnosis	:	A 2 closed
Pre op	:	10 days
Procedure	:	ORIF with LCP
Post op period	:	Unevent ful
Non-weight bearing mobilisation	:	5 days
Partial weight bearing	:	12weeks
Full weight bearing	:	18 weeks
At follow up	:	6 months
Knee flexion	:	0-100
NFKS	:	86
Result	:	Excellent

CASE - II

PRE OP AP

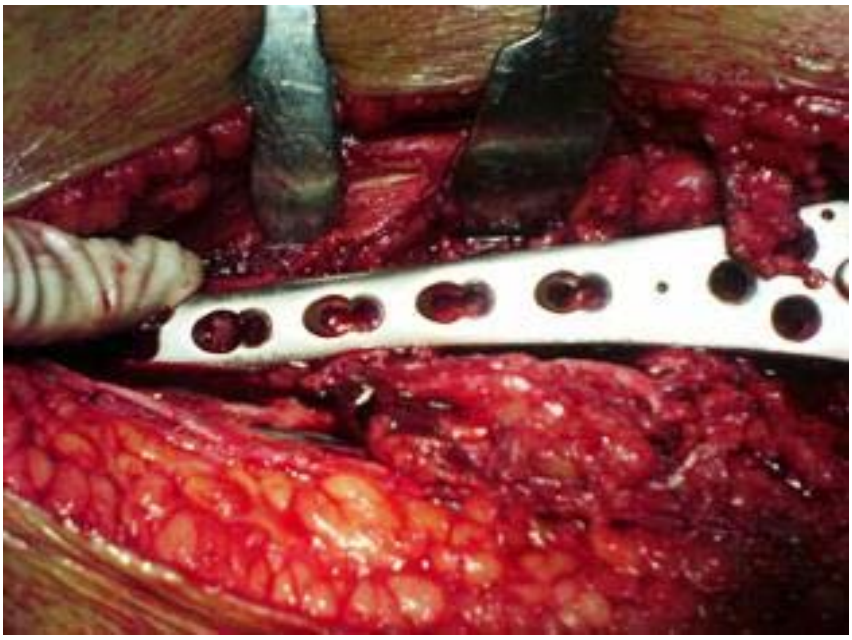
PRE OP LAT

POST OP AP

POST OP LAT

CASE - II

INTRA OP



CASE - III

Name	:	**Periyasamy 40/M**
Mode of Injury	:	RTA
Extremity	:	Left
Diagnosis	:	A 2 closed
Pre op period	:	3 days
Procedure	:	ORIF with LCP
Post op period	:	Uneventful
Non-weight bearing mobilisation	:	3 days
Partial weight bearing	:	12 weeks
Full weight bearing	:	16 weeks
At follow up	:	12 months
Knee flexion	:	0-80
NFKS	:	74
Result	:	Good

CASE - III

PRE OP AP

PRE OP LAT

POST OP AP

POST OP LAT

CASE - III

3 MONTHS AP&LAT

CASE – IV

Name	**:**	**Saraswathy 65/F**
Mode of Injury	:	Fall at bathroom
Extremity	:	Right
Diagnosis	:	C 2 closed
Pre op	:	3 days
Procedure	:	ORIF with LCP
Post op period	:	Uneventful
Non-weight bearing mobilisation	:	3 days
Partial weight bearing	:	12 weeks
Full weight bearing	:	16 weeks
At follow up	:	5 months
Knee flexion	:	0-85
NFKS	:	74
Result	:	Good

CASE – IV

PRE OP AP

PRE OP LAT

POST OP AP

POST OP LAT

CASE – V

Name	:	**Munusamy 48/M**
Mode of Injury	:	RTA
Extremity	:	Right
Diagnosis	:	A 3 closed
Pre op period	:	3 days
Procedure	:	ORIF with LCP
Post op period	:	Uneventful
Non-weight bearing mobilization	:	3days
Partial weight bearing	:	12 weeks
Full weight bearing	:	18 weeks
At follow up	:	6 months
Knee flexion	:	0-100
NFKS	:	86
Result	:	Excellent

CASE - V

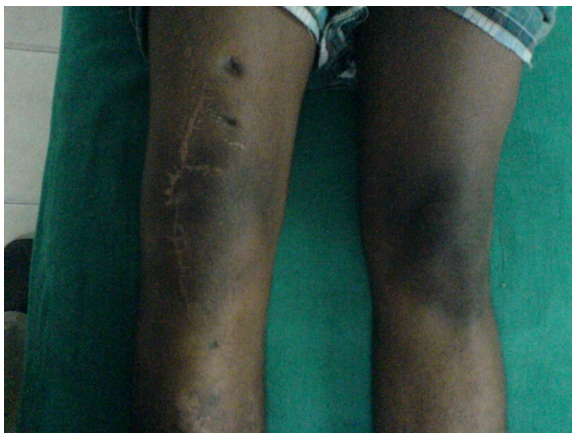
PRE OP AP

PRE OP LAT

POST OP AP

POST OP LAT

CASE - V



CASE - VI

Name	:	**Raju 24/M**
Mode of Injury	:	RTA
Extremity	:	Left
Diagnosis	:	C 2 closed
Pre op period	:	5 days
Procedure	:	ORIF with LCP
Post op period	:	Uneventful
Non-weight bearing mobilisation	:	5 days
Partial weight bearing	:	12 weeks
Full weight bearing	:	18 weeks
At follow up	:	6 months
Knee flexion	:	0-100
NFKS	:	86
Result	:	Excellent.

CASE - VI

PRE OP AP

PRE OP LAT

POST OP AP

POST OP LAT

CASE - VI

3 MONTHS FOLLOW UP

6 MONTHS POSTOP

CASE - VII

Name	:	**Sundar 53/M**
Mode of Injury	:	RTA
Extremity	:	Right
Diagnosis	:	A 2 Closed
Pre op period	:	15 days
Procedure	:	ORIF with LCP
Post op period	:	Uneventful
Non-weight bearing mobilisation	:	3 days
Partial weight bearing	:	12 weeks
Full weight bearing	:	16 weeks
At follow up	:	5 months
Knee flexion	:	0-80
NFKS	:	74
Result	:	Good

CASE - VII

PRE OP AP

PRE OP LAT

POST OP AP

POST OP LAT

CASE - VII

3 MONTHS FOLLOW UP

COMPLICATIONS

POSTOPERATIVE COMPLICATIONS

- Early complications were encountered in 4 patients. One patient, developed superficial wound infection in 1st week and was promptly treated with appropriate antibiotics, wound care and secondary suturing.
- One patient, developed pin site infection (upper tibia), where skeletal traction was applied preoperatively
- One patient developed wound gaping, due to post operative edema, which was treated by secondary suturing.
- One patient developed mild transfusion reaction (anticoagulant induced), which was treated immediately with antihistamines.

Early complications

S. No	Complications	No. of Patients
1	Superficial Wound infection	1
2	Pin site infection(upper tibial)	1
3	Wound gaping	1
4	Mild transfusion reaction (anti -coagulant, induced)	1

Late

Late complications included knee stiffness in 2 patients, in one of whom it was observed that an anterior cortical spike from distal femur irritated his quadriceps mechanism. He was taken up for 2^{nd} surgery and anterior cortical spike was removed and pericapsular adhesions were released, followed by regular physiotherapy using C.P.M machines, which improved his knee flexion from 40 degree to 90 degree. The other patient was treated conservatively.

- One patient presented with broken screw in the condylar region, in his 9^{th} month and subsequently developed pain due to prosthesis loosening and the implant was removed 1 year post surgery, after achieving good union.
- Four patients were noticed to have varus collapse of about 10 degrees with mal union.

Late Complications

S. No.	Complications	No. of Patients
1	Malunion with varus	4
2	Screw breakage	1
3	Knee stiffness	2

DISCUSSION

DISCUSSION

The use of locked plates and percutaneous techniques have evolved together while remaining true to the AO principles of internal fixation. The overlying principle is to preserve the blood supply and minimize soft tissue injury.

High energy distal femoral fractures are frequently associated with articular fracture and metaphyseal communication[1,2,3].Coronal plane fractures and extensive distal comminution generally preclude the use of traditional fixed – angle devices or retrograde nails[11]. Earlier, fixation of these fractures with a lateral plate alone has historically been associated with non-union and/or malunion with varus collapse. Prior to advent of locking plates, these problems were addressed with dual plating methods[5].

With the introduction of plates with option of locked screws, the results are encouraging, as it increases the rigidity of fixation in osteoporotic bone and in presence of periarticular or juxta-articular comminution[(12,13,17).] The LCP condylar plates provide multiple points of fixed plate to screws contact, generating greater stability and thereby reducing the tendency of varus collapse.[(17,18)] **LISS** plating allows minimally invasive approach by sub muscular insertion of plates and thereby preservation of vascularity to the lateral cortex.

We attributed the favourable results in this series by adherence to the principles of stabilization, with rigid internal fixation and early functional rehabilitation. Bone grafting was not done in any of the cases. None of the patients had loss of fixation or an aspetic non union, despite large numbers of comminuted fractures, elderly people and open fractures. Also the incidence of mal - union was low, as only four patients had 10 degree of varus mail-alignment.[21]

In our study ,radiological union was seen at an average of 14.7 weeks which is comparable to study of *LISS plates*[7,8,9] *by Max Markmiller ,et al,CORR, 2004 , that averages13.8 weeks*[8]*. Overall results were good to excellent in 9 out o*f 20 cases and were satisfactory in remaining cases. The overall average knee score in our study was80.55%, as opposed to 81% *in J.M Siliski et al, study ,JBIS.*[3]**.**

The problems in fixing distal femoral fractures with osteoporosis, extensive comminution and revision surgeries following failed implant can be addressed effectively using locking condylar plate[12,16,18].we believe that locking plates represent a valuable advancement in fracture treatment. However, the limitations of this technology and indications for its use have not been completely elucidated and the long – term results were waited.

However, the locking plates can fail when physiological loads are outside plate –design parameters [10, 17].

The locked screws can dis-engage from the plate secondary to failure of the screw to seat into the plate properly, as result of cross - threading or when insufficient screw torque is used to engage the screw threads into the plates threads [10, 17].

CONCLUSION

CONCLUSION

The LCP condylar plate is a valuable addition in the armamentarium of the orthopaedician in the management of comminuted distal femoral fractures, with questionable bone integrity. It may not completely solve the age old problems associated with any fractures. But this technique is slowly evolving as the best suited one replacing the fixed angle plate and the DCS fixation. This technique is not bereft of complications like plate or screw breakage, but careful selection of patients and strict adherence to the basic principles of fracture fixation will go a long way in reducing the complications of fracture fixation using locking compression plates.

PROFOMA

1. **Name :**
   Age/Sex :
   Occupation:
2. Address:
   Contact Number:
3. Associated Medical Illness:
4. Involved side:
5. Time and date of injury:
6. Time of arrival to hospital:
7. In patient No:
8. Mode Of Injury:
9. Treatment History:
10. Clinical Examination:
11. Associated Injuries:
12. A O Classification:
13. Initial Management given:
14. Pre-operative antibiotics used:
15. Time interval between arrival and surgery:
16. Date of surgery:
17. Type of anesthesia:
18. Preoperative X rays:
19. Surgical Procedure:
20. Approach used:
21. Implant used:
22. Bone grafting:
23. Difficulty during surgery:
24. Blood loss during surgery:
25. Duration of surgery:
26. Post operative transfusion:

BIBLIOGRAFY

BIBLIOGRAPHY

SCIENTIFIC ARTICLES

1. Supracondylar fractures of adult femur, A Study of 110 cases. Charles S.Neer, s. AshbyGrantham and marvin L.shelton, Journal of Bone and Surgery Am.june1967;49;591-613.
2. Surgical treatment of displaced, comminuted fractures of the dital end of the femur. RDMize, RW Bucholz and DP Grogan, Journal of bone and joint surgery Am .1982;64;871-879.
3. Supracondylar- intercondylar fractures of the femur. Treatment by internal fixation, J MSiliski, M Mahring and HP Hofer,Journal of Bone and Joint surgeryAm , 1989;71;95-104.
4. The result of open reduction and internal fixation of Distal femur fractures using a Biologic (Indirect) Reduction Technique. Bolhofer, Brett R.*; Caarmen, Barbara; Clifford, Philip + Journal of orthopedic trauma. 10(6); 372-377,Augut 1996.
5. New technique of treatment of unstable distal femur fractures by locked double – plating; case Report and biomechanical evaluation. Jazrawi, L M / Kummer, F J / Sim on, J A / Bai, B/ Hunt, S A/ EGOL, K A , K J, The journal of trauma, 48 (1), p.87-92,jan 2000.
6. A O Philosophy and Principles of Fracture Management-Its Evolution and Evaluation. David L.Helfet, Norbert P.Hass, Joeph Schatzker,

Peter Matter, Ruedie Moser, and Beate Hanon. J.Bone and URG. A M., June2003; 85; 1156-1160.

7. Less Invasive Stabilization Sytem for treatment of distal femur fractures. Ricci, Anthony R /yue, JamesJ/ Yue, James J / Taffet, Robert/Catalano, John B/ DeFALCO, Robert A / W likens, Kenneth. American journal of orthopedics (Belle Mead, N. J.),33(5),P.250-255,May2004.
8. Femur –LISS and Distal femur Nail for Fixation of Distal Femoral Fractures, Max Markmiller, MD, Gerhord konard, MD, AND Norbert Sudkamp, MD. Clinical Orthopedics and Related Research Number426, pp252-257, Sep2004.
9. Treatment of Distal Femur Fractures Using the LSS; Surgical experience and Early clinical results in 103Fractures.Kregor, Philip J. MD; Stannard, james A MD +; ZLOWODKI, Michael MD ++;COLE, Peter A.MD, Jpurnal of orthopedic Trauma. 18(8); 509-520,September2004.
10. Locking Compression Plate loosening and plate breakage, A Report of 4 cases, C. Sommer, R. Babst, M. Muller, B.Hanen Journal of orthopedic trauma September2004;18;571-577.
11. The Association Between Supracondylar- Intercondylar Dital Femoral Fractures and Coronal Plane FRACTURES, Sean E. Nork, Daniel N. Segina, Kamran Aflatoon , David P. Barie, M. Bradford Henley Sarah

HOLT, and Stephen K. Benirchke J.Bone Joint urg. Am., Mar2005;87;564-569.

12. Biomechanics and clinical application principles of locking plates. Christopher SOMMER, Head of Traumatology, Kantosspital, Switzerland, SUOMEN ORTHOPEDIA ja Traumato logia vol.29.jan.2006, Pages.20-24.
13. Locked Plates Combined with Minimally Invasive Insertion Technique for the Treatment of periprosthetic supracondylar fractures femur above a total knee arthroplasty.Ricci, William M. md;
14. Starr etal., 1999. Starr AJ, Jones AL, Reinert CM: The "swashbuckler": a modified approach for fractures of the distal femur. *J Orthop Trauma* 1999; 13:138.
15. Stewart et al., 1966. Stewart MJ, Sisk TD, Wallace SL: Fractures of the distal third of thefemur: a comparison of methods of treatment. *J Bone Joint Surg* 1966; 48A:784.
16. Stewart and Wallace, 1958. Stewart MJ, Wallace SL: Fracture of the distal third of the femur. *J Bone Joint Surg* 1958; 40A:235.
17. Bassett and Goldner, 1962. Bassett III FH, Goldner JL: Fractures involving the distal femoral epiphyseal growth line. *South Med J* 1962; 55:545
18. Bolhofner et al., 1996. Bolhofner BR, Carmen B, Clifford P: The results of open reduction and internalfixation of distal femur fractures

using a biologic (indirect) reduction technique. *J Orthop Trauma*1996; 10:372

19. Chiron et al., 1974. Chiron HS, Tremoulet J, Casey P, et al: Fractures of the distal third of the femurtreated by internal fixation. *Clin Orthop Relat Res* 1974; 100:160

20. David et al., 1997. David SM, Harrow ME, Peindl RD, et al: Comparative biomechanical analysis ofsupracondylar femur fracture fixation: locked intramedullary nail versus 95-degree angled plate.

21. *Jrthopuma* 1997; 11:3Gilesal.1982.Giles JB, DeLee JC, Heckman JD, et al: Supracondylar- intercondylar fractures of the femur treated with a supracondylar plate and lag screw. *JBone Joint Surg* 1982; 64A: 864.

22. Marti et al., 2001. Marti A, Fankhauser C, Frenk A, et al: Biomechanical evaluation of the less invasive stabilization system for the internal fixation of distal femur fractures. *J Orthop Trauma* 2001; 15:482.

23. Frigg. R, Locking Compression plate, An osteosynthesis plate based on the dynamic compression plate and the point contact fixator, I NJURY JOURNAL 32 S-B63-66.

24. LAST'S Anatomy, the knee joint and osteology, 10th edition, pp.130-135, 163-165.

MASTER CHART

S.No	Name	Age/ Sex	Mode of Injury	Type of Fracture	Associated Injuries	DOA	DOS	Initial Treatment	Definitive Treatment	Union in Weeks	ROM Knee Flexion	Knee Score	Complication	Follow Up (Months)
1	Suresh	23/M	Fall from height	A1 closed(L)	NIL	26.07.08	03.08.08	Thomas splint,skin Traction	ORIF with LCP	16	0-100	89	NIL	7
2	Senthil	22/M	RTA	C2 closed(L)	NIL	14.08.O8	16.08.08	UTPT	ORIF with LCP	12	0-100	86	Superficial wound infection	12
3	Ravi	28/M	RTA	A3 closed(R)	NIL	26.08.08	29.08.08	High AK SLAB	ORIF with LCP	12	0-100	76	NIL	6
4	Kalaiselvam	21/M	RTA	C2 closed(L)	NIL	24.07.08	01.08.08	Thomas splint	ORIF with LCP	16	0-90	73	Early knee stiffness	10
5	Ramanathan	55/M	RTA	C2 closed(L)	NIL	02.09.08	08.09.08	Thomas splint	ORIF with LCP cancellous screw	16	0-80	74	NIL	12
6	Venugopal	28/M	RTA	C2 closed(R)	Metatarsal # 2,3 (L)	01.09.08	14.09.08	UTPT	ORIF with LCP	18	0-80	73	NIL	5
7	Arumugam	40/M	RTA	C2 closed (L)	NIL	15.09.08	23.09.08	UTPT	ORIF with LCP	16	0-90	86	NIL	5
8	Seetha	38/F	RTA	C1 closedR)	Nil	02.10.08	05.10.08	Thomas splint	ORIF with LCP+Cancellous Screw	16	0-80	74	NIL	12
9	Rajendran	28/M	RTA	A1 closed(L)	NIL	06.10.08	26.10.08	UTPT	ORIF with LCP	20	0-100	80	NIL	6

S.No	Name	Age/ Sex	Mode of Injury	Type of Fracture	Associated Injuries	DOA	DOS	Initial Treatment	Definitive Treatment	Union in Weeks	ROM Knee Flexion	Knee Score	Complication	Follow Up (Months)
10	Kuppammal	65/F	Fall at bathroom	C1 closed(L)	NIL	09.11.08	19.11.08	UTPT	ORIF with LCP	12	0-100	86	Pin site infection	3
11	Ramasamy	40/M	RTA	C1 closed(L)	Type IV schatzker (L)	06.12.08	11.12.08	Thomas splint	ORIF with LCP+Cancellous Screw	16	0-110	89	NIL	20
12	Saradambal	53/F	RTA	A2 closed(R)	Distal radius # (R)	10.12.08	25.12.08	UTPT	ORIF with LCP	14	0-80	71	NIL	5
13	Saraswathy	65/F	RTA	C2 closed(R)	NIL	07.01.09	10.01.09	Thomas splint	ORIF with LCP	16	0-85	71	NIL	5
14	Muniammal	66/F	RTA	C2 closed(R)	NIL	24.01.09	30.01.09	High AK SLAB	ORIF with LCP	16	0-80	81	NIL	6
15	Kandhavel	55/M	Fall at stairs	C2 closed(L)	NIL	14.02.09	08.02.09	UTPT	ORIF with LCP	14	0-80	76	Superficial wound infection	10
16	Raju	24/M	RTA	C2 closed (R)	Nil	02.05.09	08.05.09	High AK SLAB	ORIF with LCP	12	0-100	86	NIL	4
17	Kumeresan	42/M	RTA	C1 closed(L)	NIL	02.06.09	07.06.09	Thomas splint	ORIF with LCP	14	0-100	74	NIL	4
18	Pushpa	48/F	Fall from height	A3 closed(L)	NIL	14.06.09	19.06.09	UTPT	ORIF with LCP	14	0-105	87	NIL	4
19	Arokiasamy	46/M	Fall from height	C2 closed(L)	NIL	18.06.09	23.06.09	UTPT	ORIF with LCP	12	0-100	89	NIL	4
20	Periyasamy	62/M	RTA	A3 closed(L)	NIL	24.06.09	30.06.09	UTPT	ORIF with LCP	12	0-80	74	NIL	4